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**Identification of Target Bioallergens: Frequency of Specific Aeroallergen  
Sensitization in an Atopic Population in the Sacramento Region**

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Agency

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## Table of Contents

Title Page.....	i
Disclaimer.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
Abstract.....	v
Executive Summary.....	vi-vii
Final Report.....	1-12
Body of Report.....	1-7
References.....	8
Table 1.....	9
Table 2.....	10
Figure 1.....	11
Figure 2.....	12
Figure 3.....	13

## Abstract

Charts from individuals who filled out a questionnaire and underwent skin testing at Kaiser Permanente clinics in the greater Sacramento area in the year 2000 were pulled for review. 566 subjects had a physician diagnosis of allergic rhinitis or asthma and were included in the analysis. Grass pollens (60% of patients), olive pollen (57%), and dust mites (49%) were the most frequent positive skin tests in patients with allergic rhinitis or asthma. Sensitization (i.e., a positive skin test) to mold allergens was much less common, but *Alternaria* was the most common mold allergen extract giving a positive skin test (24% of patients). Young adults from ages 20-39 had more positive skin tests than other age groups. Logistic regression analysis showed grass pollen sensitization to be significantly associated with asthma. Positive skin tests to cat or dog were more frequently seen in patients with moderate/severe asthma than mild persistent asthma. Overall, our results indicate a high frequency of sensitization to grass pollens and olive pollen in both patients with allergic rhinitis or asthma from the inland valley areas of Northern California, suggesting that these are the key pollens, and *Alternaria* the key mold spore, to examine in future studies of aeroallergen/pollutant interactions in California.

## Executive Summary

**Background:** It is known that indoor allergen sensitization plays an important role and even critical role in the chronic inflammation characteristic of asthma.<sup>1</sup> Episodic aeroallergen exposures that occur seasonally are also known to cause asthma attacks but much less work has been done to attempt to document aeroallergen exposure from pollens or molds during exacerbations. In California, a review of medical records at the David Grant Medical Center located on the Travis Air Force Base in Fairfield, California, revealed an association between sensitization to grass pollen, grass pollen counts and emergency department visits for asthma and allergic rhinitis.<sup>2,3</sup> Several studies in California have suggested a potential role of exposure to elevated fungal spore counts.<sup>6,7</sup> No data is available on the valleys further inland where the relative contributions of standard measures of air quality vs. pollen/spore burden are also of great concern. The “conventional wisdom” among allergists in the Sacramento area, which is unproven, is that olive pollen, grass pollen and *Alternaria* spores (reportedly released in huge amounts during tomato harvesting season) are responsible for severe asthma attacks in many allergic asthmatics during specific seasons. Herein, we sought to demonstrate to which allergens individuals are most frequently sensitized as determined by skin prick tests in a population of patients in the Sacramento area with allergic rhinitis or asthma.

**Methods:** A retrospective, cross-sectional observational study of patients followed at Kaiser Permanente of Northern California was performed. Patients were selected who had been to an allergist and had skin testing in the year 2000. Questionnaires filled out by patients described self-reported symptoms and environmental history. Skin tests and the physicians’ final diagnoses were reviewed. Data was entered on an Excel spreadsheet then transferred to SAS for analysis. The factors impacting a positive diagnosis of Asthma and/or Allergic Rhinitis were examined using logistic regression methods. An overall measure of patient sensitivity was calculated as the first principal component from the results of all of the allergy skin tests and was included in the logistic regression models to distinguish between the effect of general sensitivity and of sensitization to particular allergens.

**Results:** 566 subject charts were eligible for inclusion based on a diagnosis of allergic rhinitis or asthma. Of the pollens used for skin testing, grass pollens and olive pollen most commonly elicited positive skin tests in this group of patients (60% and 57% respectively). In fact, sensitization to olive pollen was more frequent than sensitization to any other tree pollen. Mold sensitization was much less common, but *Alternaria* was the most common mold allergen eliciting a positive skin test (24%). Young adults from ages 20-39 had more positive skin tests than other age groups. There were no specific allergen sensitizations that were predictive of allergic rhinitis, but grass pollen sensitization was associated with a diagnosis of asthma ( $p = .001$ , OR 2.15) in this geographic area. Among patients diagnosed with asthma, positive skin tests to cat and dog were seen more frequently in those with moderate/severe asthma compared to patients with mild persistent asthma.

**Conclusions:** Among patients with a physician diagnosis of asthma or allergic rhinitis, positive skin tests to olive and grass pollens were most frequently found.. Olive pollen sensitization was significantly more common than sensitization to the other tree pollens. Among the grass pollens, there was no significant difference in the prevalence of sensitization. Grass pollen sensitization was positively associated with a diagnosis of asthma. Positive skin tests to cat, dog or dust mites

were more frequently seen than mold sensitization. We can conclude that olive pollen, grass pollen (represented by either or both Bermuda or perennial rye which are the most common species present), and of the molds, *Alternaria*, together represent key aeroallergens that could be studied by the ARB in research initiatives targeting allergen/pollutant interactions in Northern California's inland valley region.

## Final Report

### Introduction.

It is known that indoor allergen sensitization plays an important and even critical role in the chronic inflammation characteristic of asthma.<sup>1,2</sup> Episodic aeroallergen exposures that occur seasonally are also known to cause asthma attacks but much less work has been done to attempt to document aeroallergen exposure from pollens or molds during exacerbations.<sup>3,4</sup> Such exposures are extremely dependent on the specific geographic area being studied. In California, a review of medical records at the David Grant Medical Center located on the Travis Air Force Base in Fairfield, California, revealed an association between sensitization to grass pollen, grass pollen counts and emergency department visits for asthma and allergic rhinitis.<sup>3,5</sup> Several studies in California have suggested a potential role of exposure to elevated fungal spore counts and asthma disease stability. Fungal spore counts were associated with asthma symptoms and medication use in a panel study of asthmatic children in Los Angeles<sup>6</sup> and with asthma symptoms, medication use and peak flow values in a panel study of asthmatic adults and children from a semi-rural area in Southern California.<sup>7</sup> No data is available on the valleys further inland where the relative contributions of standard measures of air quality vs. pollen/spore burden are also of great concern.

The “conventional wisdom” among allergists in the Sacramento area, which is unproven, is that olive pollen, grass pollen and *Alternaria* spores (reportedly released in huge amounts during tomato harvesting season) are responsible for severe asthma attacks in many allergic asthmatics during specific seasons: April-June for grass, May for olive, and September-October for *Alternaria*). Herein, we sought to demonstrate which allergens most frequently elicit positive skin tests, indicating the presence of allergen specific IgE, in a population of patients in the Sacramento area with allergic rhinitis or asthma. We also sought to determine if sensitization to any allergen was significantly associated with a diagnosis of asthma, allergic rhinitis, or the presence of both disorders, compared to allergic rhinitis alone. It should be noted that the presence of allergen specific IgE by prick skin test, indicating sensitization, does not equate to a clinical allergic response to that allergen, which is demonstrated by nasal or bronchial challenge. However, prick skin testing has shown excellent diagnostic efficiency when followed by allergen challenge and is an easily performed test.<sup>8</sup>

### Materials and Methods

A retrospective, cross-sectional observational study of patients followed at Kaiser Permanente of Northern California was performed. Patients were selected who had been to an allergist and had skin testing. Questionnaires filled out by patients described self reported symptoms and environmental history. Skin tests and the physicians’ final diagnoses were reviewed. Data was entered on an Excel spreadsheet then transferred to SAS (SAS Institute, Cary, NC) for analysis.

Data entered included:

- i. Age at skin testing (grouped by decade up to 60+)
- ii. Skin testing site
- iii. Sex
- iv. Date of skin test (the season does not affect whether a test is positive or negative; this was for reference only to make sure charts were



- pulled from the entire year)
- v. Immunotherapy history, yes or no – we excluded those on immunotherapy at the time of skin testing. (Skin testing is not usually performed except in the initial allergy intake exam.)
  - vi. Smoking history (current, ever, never).
  - vii. Allergic rhinitis, presence or absence of, self-reported and allergist diagnosis
  - viii. Asthma, presence or absence of, self-reported and allergist diagnosis
  - ix. Asthma severity by specific allergist diagnosis (NIH Asthma Guideline criteria are followed by Kaiser Permanente allergists)
  - x. Current cat owner, yes or no
  - xi. Current dog owner, yes or no
  - xii. Presence or absence of visible mold growth in the home, self-reported
  - xiii. State of birth
  - xiv. Number of years in California
  - xv. Number of years in Sacramento region
  - xvi. State of residence when the symptoms started, if noted
  - xvii. City of residence
  - xviii. Thirty aeroallergens were recorded, scored as +/- by standard criteria (greater than 3 millimeters [mm] induration compared to negative control is the U.S. standard for a + test). Tests were recorded in mm induration/mm erythema. All sites used the same extracts (from Hollister-Stier, Spokane, WA), same prick test points and same techniques. Inter-observer variability is extremely low when results are +/- rather than 0 to 4+. Seasonality of testing does not change negatives to positives but does influence the size of reactions – another reason we used only +/- scoring. Allergens: Bermuda grass, perennial rye grass, Timothy grass, Kentucky blue grass, oak mix, black walnut, cottonwood, mulberry, Chinese elm, olive, ash, Western ragweed, pigweed, lamb's quarters, Russian thistle, English plantain, cat, dog, *D. farinae*, *D. pteronyssinus*, *Alternaria*, *Aspergillus*, *Penicillium*, *Cladosporium*, acacia, alder, maple, birch, sycamore, pine (controls, histamine and saline). These 30 allergens were agreed upon by a panel of Kaiser Permanente allergists for use in this geographic area based on the National Allergy Bureau Pollen/Spore Reports. It is certainly possible that patients may be sensitized to other allergens, but the most commonly studied aeroallergens are represented by this panel.

Statistical analysis. The data set was copied into SAS format. Descriptive outputs based on age and diagnoses were generated. In examining which allergens might be associated with diagnoses of allergic rhinitis or asthma, a principal component analysis (PCA) was run that included groupings of results, such as all allergens, or grasses, for example. The goal was to see how the results co-vary (“go together”), which in turn would imply what variables would be confounded with each other. The first principal component from this analysis served as a

measure of general sensitivity, or atopy. Next, stepwise logistic regression analysis was performed, that included the first principal component as a factor, and then asking whether any of the individual tests added significantly to that measure of general sensitivity in predicting asthma or allergic rhinitis. Logistic regression analysis was also performed without the principal components input in the analysis of some of the demographic information and the diagnoses of asthma or allergic rhinitis. Sign tests and the Binomial distribution were used to compare single allergen frequencies with others. Chi square analyses were performed for direct comparisons between two groups. The Mann Whitney test was used for nonparametric comparisons between diagnosis groups with respect to the numbers of positive skin tests. To determine if there were effects of age on skin test results, one-way ANOVA was performed with the dependent variable either the total number of positive skin tests or the number of positive skin tests to pollens. Frequencies of positive reactions to the two dust mites, *D. pteronyssinus* and *D. farinae*, were subjected to logistic regression to determine if reactivity was associated with age. Frequencies of positive reaction were further compared pairwise by age group using Chi-square.

## Results

**Descriptive statistics.** Initially, 790 charts were studied, but 566 were included in the final analysis. There were 51 incomplete skin test records and 3 duplicate entries, resulting in 736 complete charts to review. The average patient age was 35.5 years old with a range of 2 to 83 years old. Fifty-seven percent of the patients were female. Forty-four percent were dog owners and 40% owned cats. Seven percent were current smokers, and 19% had smoked in the past. Twenty-four percent of patients reported visible mold contamination in their home. Symptoms prompting allergist evaluation included: 94% with rhinitis and 54% with lower respiratory symptoms. Ninety-three percent complained of symptoms starting since residence in California. There was a high rate of atopy with 75% of patients having one or more positive skin tests. A total of 67% of patients were diagnosed with allergic rhinitis. Asthma was diagnosed in 38% of patients with varying degrees of severity. 170 patient charts did not have a physician (allergist) diagnosis of allergic rhinitis or asthma. These patients were predominantly individuals with COPD, chronic sinusitis and non-allergic rhinitis and were eliminated from analysis. Thus, 566 patient charts from patients who were given a physician diagnosis of asthma or allergic rhinitis met the criteria for further analysis and are further described in **Table 1**. The principal components analysis showed that the first component was by far the largest one; it put positive weights on all of the individual tests, with the exception of the controls, saline and histamine, which were constant. This showed that the major way in which subjects vary is that some have multiple positive results, while others have comparatively fewer positive results.

**Skin test results.** **Table 2** shows the frequency of positive skin tests to the different allergens based on diagnosis. Of the pollens used for skin testing, grass pollens and olive pollen most commonly elicited positive skin tests in this geographic area. In fact, sensitization to olive pollen was more frequent than sensitization to any other tree pollen ( $p < .0001$ ) (57% in patients with allergic rhinitis or asthma, and 65% in patients with allergic rhinitis and asthma). However, there were no significant differences among the different species of grasses.

**Effect of age on skin test results.** Not seen in **Table 2**, but appreciated from **Figure 1**, is that young adults were significantly more frequently sensitized to pollens and the other allergens in

general. Using one-way ANOVA models for age groups, the age groups 20-29 and 30-39 are not different from each other and are significantly more often sensitized to aeroallergens than the 0-9, 10-19, 40-49, and >60 age groups for a model for the set of all allergens (i.e., the number of positive skin tests as the dependent variable) ( $p < .05$ ). Patients were grouped into decades because patients being evaluated in early childhood may be different than those being evaluated at an older age for asthma or allergic rhinitis; to maintain consistency, the decade grouping was continued. When pollen sensitization alone is examined by age, the age groups 20-29, 30-39 and 50-59 are not different, but more frequently have positive skin tests to pollens than the age groups 40-49, 10-19 and 0-9, which all show more positive skin tests to pollen extracts than age groups >60 ( $p < .05$ ). However, there is an interesting effect of age on dust mite sensitization when looked at separately. When a logistic regression model is applied to the two dust mites, significant age effects were identified (for *D. pteronyssinus*,  $p = .0003$ , and for *D. farinae*,  $p = .0004$ ). Frequencies of positive reactions were further compared pairwise by age group using Chi-squares. These comparisons clearly identified elderly individuals (>70 years of age) as collectively having a higher frequency of positive skin tests to dust mites than all other age groups except age 20-29 ( $p \leq 0.05$ ), but the number of individuals in this age group was small. In other words, there is a likely a second peak of sensitization for age >70. There is no indication of a second peak of sensitization for any other allergen. This is consistent with what we have observed clinically in our Sacramento VA Allergy Clinics: older patients more commonly present with dust mite allergy as a mono-sensitization than young adults. **Figure 1** depicts the frequency of positive skin tests to several allergens in those with allergic rhinitis as an example of the effect of age.

**Visible mold and the association with positive skin tests to molds or a diagnosis of allergic rhinitis.** Only four species of fungi were tested. These four species are the most commonly implicated in clinical allergy.<sup>9</sup> *Alternaria* is the genus of the major outdoor mold in the United States. It sporulates during dry weather and in the Sacramento area can be detected from spring through fall. *Cladosporium* is another outdoor mold with similar sporulation requirements. *Aspergillus* and *Penicillium* species are considered the most important indoor mold contaminants across the United States. The questionnaire included a query on whether visible mold was in the home. Although many people reported visible mold, there was no relationship between self-reported mold and positive skin prick tests to the four mold extracts tested. **Figure 2** depicts these results. Mold in homes as a source of exposure may go undetected, and confounded by work, school, and other exposures. Thus any analysis of mold presence and positive skin tests is really not valid unless the actual mold spore/aerosolized hyphae exposure over time of that patient is known, broken down by species – a thoroughly daunting task as there are several hundred molds that can be present in homes. There was also no relationship between positive skin tests to any of the specific molds and the diagnosis of allergic rhinitis by logistic regression. Given the limitations of the data at hand, it is evident that further analysis of presumptive mold exposure and other variables cannot be done.

**Positive skin tests to specific allergens and the diagnosis of asthma or allergic rhinitis or both.** Looking at individual allergens in association with asthma or allergic rhinitis was done after adjusting for the subjects' general level of sensitivity (the first principal component) from the principal components analysis. Logistic regression was performed including the first principal component and then asking whether any of the individual tests added significantly to

that factor in predicting either allergic rhinitis or asthma. For allergic rhinitis, there were no allergens for which a positive skin test was positively associated with rhinitis beyond the first principal component. For asthma, the only additional factor that entered the model was a positive skin test to grass pollen, with perennial ryegrass pollen used as the factor, which was positively associated with asthma ( $p = 0.001$ ), with an odds ratio of 2.15.

Patients with asthma and allergic rhinitis showed a trend towards an increased frequency of positive skin tests towards dust mites, animal dander, ragweed, and several tree pollens but not grass or olive pollen (which may reflect an already high prevalence of skin test positivity: ~60%) or molds when compared with patients with allergic rhinitis alone. This did not reach statistical significance. A *post hoc* Mann Whitney test showed that the group with “asthma only” had fewer positive skin tests than either those with allergic rhinitis or both allergic rhinitis and asthma ( $p < .0001$  in both comparisons).

**Severity of asthma in association with sensitization to specific allergens.** When the severity of asthma was examined by Chi-square against positive skin tests to cat or dog, the moderate/severe asthma group was significantly more likely to have a positive skin test to cats and dogs ( $p = 0.027$ , and  $p = 0.026$ , respectively) than the mild persistent group, as graphed in **Figure 3**. The differences were not significant for olive pollen, dust mite (*D. pteronyssinus*), or grass pollen (Kentucky bluegrass as an example). None of these relationships was significant against the group with intermittent asthma.

**Prevalence of atopy in patients with asthma only.** An interesting finding is the lower prevalence of atopy among patients diagnosed with asthma only. Indeed, they are significantly less atopic (based on the number of positive skin tests) than patients with allergic rhinitis and asthma or allergic rhinitis alone ( $p < .0001$ ). This is to be expected, since it is now known that allergic rhinitis is a significant risk factor for the later development of asthma; cumulatively, most asthmatics are atopic.<sup>1</sup> Thus, the majority of asthma patients will present with both conditions. Consistent with other literature, 26% of the asthmatics in our group did not have allergic rhinitis symptoms and fell under this “asthma only” category. Clinically, it is still relevant that 24% and 31% of this group were positive on skin testing with cat or dust mites, respectively. Interestingly, in this group, positive skin tests to dust mites (30.6%) (*D. pteronyssinus*) were significantly more common than to olive pollen (15.3%) ( $p = .013$ ).

**Effect of gender.** There was no association for asthma or allergic rhinitis or specific tests with gender.

**Effect of site of skin testing:** It was found that patients from throughout the geographic area were represented at the different clinic sites so that this was not a valid analysis. For example, patients from Davis were tested in Roseville, Rancho Cordova or Sacramento, while Roseville residents could also be found at the Rancho Cordova site. This probably represents an effect of workplace location or ease of obtaining an appointment at the different sites.

**Effect of date of skin testing:** no effect seen.

**Effect of cigarette smoking:** There was no association for either allergic rhinitis or asthma with whether a subject had ever smoked. Data on environmental tobacco exposure was not obtained.

**Effect of pet ownership:** There was no association with owning dogs or cats for asthma or allergic rhinitis. Information on past pet ownership, particularly exposure during infancy which may actually be protective, was not available.

**Obstacles to generalizing from the study group to the larger population.** Although it is reassuring that the results from this study do closely resemble the results of a smaller study (see below in Discussion, reference 10), there are limitations. There are many microenvironments in California – in some areas, grasses are not as common, and olive trees would not be found. The Kaiser Permanente patient population is likely better off financially than much of California's population. For instance, in this Kaiser Permanente patient population, rat and mouse allergens are not part of the routine skin test panel, but these allergens are now considered important in selected populations. It would be ideal to have full information about past residences and the year of onset of allergic rhinitis or asthma symptoms in order to ascertain geographic influences.

**Additional questions asked by ARB staff, to be included if possible: Effect of years in California, years in the Sacramento area or city of current residence:** no effects were seen in logistic regression analysis for the effect of years in California or the years in the Sacramento region. This may have been partly due to an effect of age, but the information from the questionnaires was too incomplete to accurately group patients. In an attempt to examine the effect of city of current residence, cities were grouped into 3 zones: Gold Country, North Sacramento and Sacramento area (other areas). The analysis was discarded when it was apparent that workplaces and years of residences crossed all these zones.

## **Discussion**

There exists only one study in California that evaluated the prevalence of IgE sensitization to aeroallergens by the use of skin prick testing among patients with a diagnosis of asthma and/or allergic rhinitis.<sup>10</sup> In 1997, 141 patients throughout California were skin tested with 103 allergens. Only 26 patients from Northern California were included. For comparison, in that study, 52% were positive by skin testing to perennial ryegrass, while we found 60% ; 46% to Bermuda grass, we found 60%; both studies found about 30% to be positive to the major California weeds; 42% were positive to olive in the earlier study, we found 57%; 18% to *Alternaria* mold, we found 24%; 53% to dust mites, we found 49%, and 39% to cats, we found 41%. Importantly for the ARB, the combined results suggest that Northern and Southern California are very similar in terms of sensitization to aeroallergens as determined by skin prick testing. Notably, in our clinical experience many patients present to the allergist's office complaining of pine pollen allergy. This survey confirmed others' findings that such sensitization is actually quite uncommon.<sup>11</sup> The potential importance of sensitization to grass pollen in asthmatic individuals in Northern California was supported by this study. Grass pollen sensitization was the only variable that was positively associated with a physician diagnosis of asthma beyond general atopy, with an odds ratio of 2.15. This analysis was conducted using stepwise logistic regression methods, which are subject to a high false positive error rate. Thus

the lack of significance for the other tests is noteworthy in light of the high expected false positive rate. Although sensitization to cat or dog did not emerge in the analysis as a predictor for asthma, such sensitization was significantly associated with moderate/severe asthma versus mild persistent asthma.

## **Summary and Conclusions**

Of the aeroallergens used for skin testing, grass pollens and olive pollen most commonly elicited positive skin tests in patients in this geographic area. In fact, sensitization to olive pollen was more frequent than sensitization to any other tree pollen ( $p < .0001$ ). Sensitization to indoor allergens was common, but positive skin tests to such allergens were less frequently seen than to olive and grass pollens. In fact, a positive skin test to grass pollen, represented by perennial ryegrass in the analysis, was the only skin test result in this group of patients that was significantly associated with a diagnosis of asthma when accounting for generalized reactivity to multiple allergens. We can conclude that grass pollen olive pollen, and of the molds, *Alternaria*, together represent key aeroallergens that could be studied by the California ARB in research initiatives targeting allergen/pollutant interactions in Northern California's inland valley region.

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**Table 1. Summary of characteristics of the 566 eligible patients**

Mean Age	34 years			
Age Range	2-79 years			
Sex	Male 258 (45.6%)	Female 308 (54.4%)		
Dog ownership	Yes 240 (42.4%)	No 308 (54.4%)	Not stated 18 (3.2%)	
Cat ownership	Yes 228 (40.3%)	No 319 (56.4%)	Not stated 19 (3.4%)	
Current smoker	Yes 36 (6.4%)	No 513 (90.6%)	Not stated 17 (3.0%)	
Ever-smoker	Yes 138 (24.4%)	No 411 (72.6%)	Not stated 17 (3%)	
Visible mold in the home	Yes 118 (20.8%)	No 325 (57.4%)	Not stated 123 (21.7%)	
Allergic rhinitis, self-reported	Yes 535 (94.5)	No 31 (5.5%)		
Allergic rhinitis, physician diagnosed	Yes 494 (87.3%)	No 72 (12.7%)		
Asthma, self-reported	Yes 332 (58.7%)	No 232 (41%)	Not stated 2 (0.3%)	
Asthma, physician diagnosed	Yes 278 (49.1%)	No 288 (50.9%)		
State of residence at the onset of symptoms	California 458 (80.9%)	Other state 27 (4.8%)	Other country 9 (1.6%)	Not stated 74 (13%)

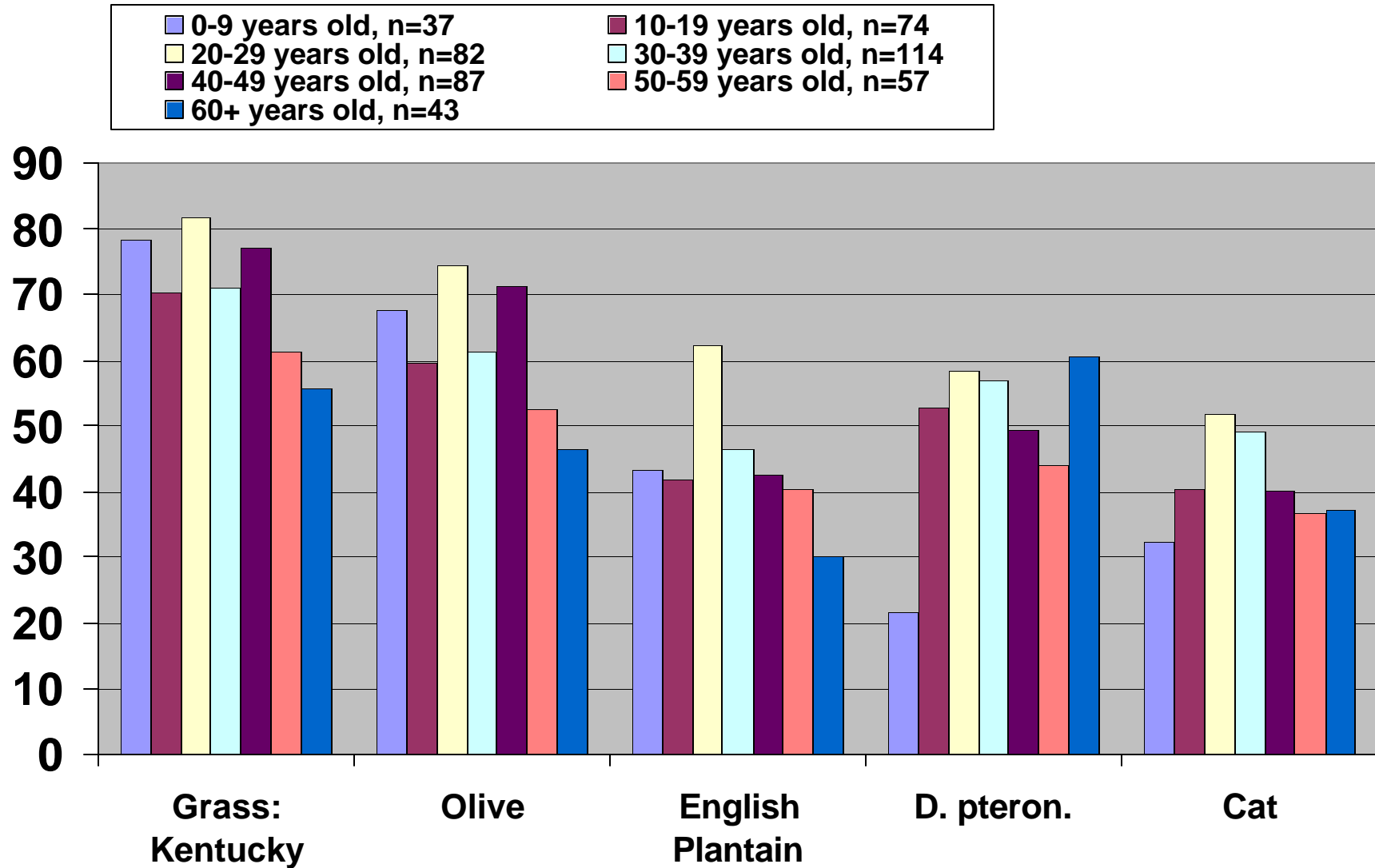


**Table 2. Summary of positive skin tests based on physicians' final diagnosis**

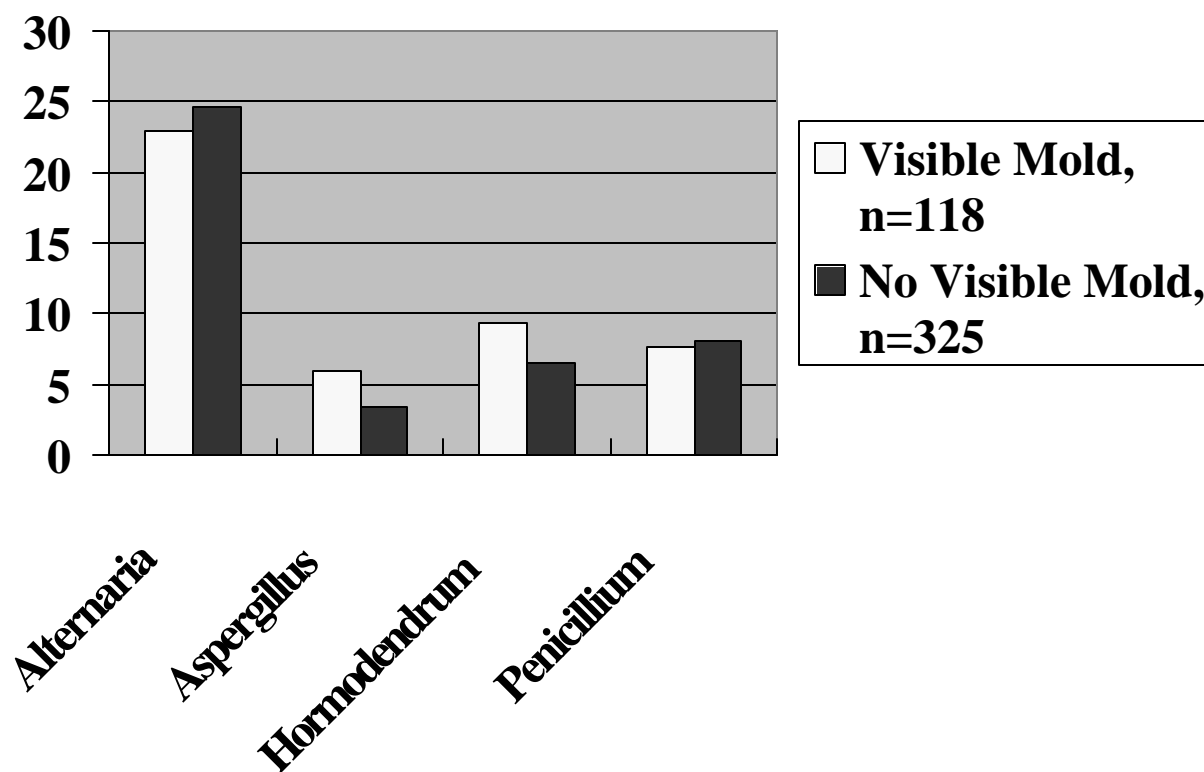
Allergen	AR <sup>1</sup> or Asthma n=566	AR only n=288	Asthma only n=72	AR and Asthma n=206
<b>Grasses</b>				
Bermuda	60.1%	64.6%	18.1%	68.4%
Kentucky	65.4	71.5	20.8	72.3
Perennial Rye	60.4	67.0	19.4	65.5
Timothy	60.4	65.3	19.4	68.0
<b>Weeds</b>				
English Plantain	40.5	42.4	6.9	49.5
Lambs Quarters	25.6	28.5	8.3	27.7
Pigweed	37.7	38.2	11.1	46.3
Russian Thistle	24.9	24.7	5.6	32.0
West. Ragweed	35.3	34.0	9.7	46.1
<b>Trees</b>				
Acacia	39.0	38.5	11.1	49.5
Alder	29.5	30.6	4.2	36.9
Ash	37.3	40.3	11.1	42.4
Birch	36.1	35.5	8.3	46.6
Black Walnut	30.9	30.6	5.6	40.3
Box Elder/Maple	33.9	35.8	6.9	40.8
Chinese Elm	38.7	41.0	5.6	47.1
Cottonwood	21.6	22.9	4.2	25.7
Mulberry	37.3	39.6	6.9	44.7
Oak	39.4	40.6	6.9	49.0
Olive	57.1	61.8	15.3	65.0
Pine	2.5	2.4	1.4	2.9
Sycamore	34.1	33.7	6.9	44.2
<b>Animal Danders</b>				
Cat	40.5	38.9	23.6	48.8
Dog	28.8	25.3	16.7	37.9
<b>Dust Mites</b>				
D. farinae	36.6	35.4	15.3	45.6
D. pteronyssinus	48.8	47.9	30.6	56.3
<b>Molds</b>				
Alternaria	23.9	24.3	9.7	28.2
Aspergillus	3.7	2.8	4.2	4.9
Hormodendrum	6.9	5.9	2.8	9.7
Penicillium	8.3	9.0	5.6	8.3

<sup>1</sup>AR = Allergic rhinitis

Figure 1. Comparison of frequency of positive skin tests by age for selected allergens in patients with allergic rhinitis diagnosed. The only allergen that underwent statistical evaluation separately was *D. pteronyssinus*. The others are shown for example of the age and sensitization trends.



**Figure 2.** Frequency of sensitization to molds based on self-report of visible mold contamination in the home.



**Figure 3.** Frequency of sensitization to common allergens by severity of asthma

